stated simply, distinctly, and in proper succession; and a considerable mass of useful information, not however of such immediate necessity, is thrown into a copious appendix. We are particularly pleased with the key of vowel sounds, (p. 3.) and think it decidedly the best we have seen for plainness and accuracy; though we feel some disposition to dispute the sound given in it to the point *Pathah.* In the verbs we are glad to see the old term *conjugation,* which has so long been the crux Judaïca to all such as had been accustomed to attach a different sense to it in the Greek and Latin, discarded, and the more proper one of *form* substituted after the German grammarian Vater. The paradigms of verbs are far more correct than in any other grammar we have seen. We have found several errours corrected in them from one of the best editions of Yates, with which we compared them. This will appear a circumstance of no small consequence to any who have known, as we have, the misery of using a careless edition. The syntax is very full on all the peculiarities of Hebrew construction.

The typographical execution of the work is highly honourable. If publick patronage should ever justify the undertaking, we should be very glad to see the first American edition of the Hebrew scriptures from the same press.

ART. IV. *A Manual of Mineralogy, by Arthur Aikin, Secretary to the Geological Society; first American from the second London edition.* pp. 275, 12mo. Philadelphia, 1815.

SYSTEMS of mineralogy originated in the necessity for some kind of arrangement for stones. The first was probably an arbitrary classification, for chemistry had not then determined the composition of many minerals. Stones were divided and arranged according to a few of their external marks. Perhaps only their colour and hardness were noticed, all the hard and red stones forming one class, all the soft and red another, and so on.* As scientifick knowledge was

* Theophrastus, in his book ΠΕΡΙ ΤΩΝ ΛΙΘΩΝ, mentions as their characters, the qualities, smoothness, density, brightness, and transparency with the different effects of fire on minerals; but he has given no systematick arrangement.

diffused wider, endeavours were made to advance mineralogy to an equal standing with the other branches of Natural History. Linnaeus attempted to arrange minerals by a classification analogous to that which he had so successfully applied to zoology, botany, &c. and made a regular division of the mineral kingdom into earths, salts, inflammables, metallick ores and organick remains, but did not give any precise characters, by which to distinguish these classes. The sapidity and solubility of salts, and the combustibility of inflammables may distinguish these two classes; but the remaining three have no characteristick marks. Others have divided minerals into earths, stones, salts, inflammables, and metallick substances,* and taking superficial marks for their guide, have classed those substances together, which are most dissimilar, and separated those most nearly allied in their composition.

The obstacle to the formation of any scientifick arrangement of minerals, is the difficulty of determining what constitutes a mineral species, the want of a fixed and invariable point from which to begin. In organized nature the species are determined by invariable characters, transmitted from one individual to another; and it is in like manner an invariable character, to which we must look as the foundation of a mineralogical arrangement. What then constitutes this character? Colour does not; nor form, hardness, transparency, or any other external mark. These are all variable, and nothing in minerals is determinate but their chemical composition. All, which possess the same composition, belong to the same species; and it is a knowledge of this only, which can lead to proper specifick distinctions.

Cronstedt first began to perceive the influence, which chemistry ought to have in mineralogy. He first made the division of minerals into earths, metals, salts, and inflammables, and derived his orders and genera from the chemical constitution of stones; and his arrangement is to this day the basis of mineralogical classification. Mineralogy must go step for step with chemistry. Improvements in the latter will introduce alterations and new arrangements into the former. Cronstedt's book was "chiefly intended as a bar and opposition to those who imagine it to be an easy

* Forster's Introduction to Mineralogy, London, 1768, 8vo.

thing to invent a method in this science, and who, entirely taken up with the face of things, think the mineral kingdom may be divided into classes, orders, and genera with the same facility, as animals and vegetables;" he "hopes to obtain some protectors against those who are possessed with the *figuromania*, and who are shocked at the boldness of calling a marble a limestone, and the placing of porphyry amongst the saxa." But, it may be asked, must the mineralogist always call in the aid of the chemist, before he can examine a mineral. This question, says Barzelius, distinguishes the mere collector of stones from the true mineralogist; the former seeks a name for his specimen, the latter wishes to know its nature. One indeed, guided wholly by external characters, in determining the nature of a mineral, will be much deceived, if he looks for a silex, and blunders by chance on the thirteenth species of Jameson's flint genus; or for an argillaceous substance, and takes the third subspecies of the second species of the clay genus. We do not deny the great utility of external characters. They must be employed to identify the species, when the chemist has determined what it is; each individual mineral cannot be analysed, nor perhaps, if it were practicable, would it be useful; but when the analysis has once been made, a similarity of composition will be found in other specimens, which closely agree with it in all its external characters.

The two great masters of mineralogy of the present day, both admit chemistry to a participation in the foundation of their systems; and agree that a species consists of the same substances, united in the same proportion. Yet Werner, in the details of his system, depending on external characters, separates species, which have no difference of composition, and places others in the same group, which differ altogether in their nature. Apatite, and asparagrass stone, constitute two species according to Werner; yet they both consist of lime and phosphorick acid, and differ very little in their external marks. Here is a distinction without difference. The same mineralogist places the sapphire among the flint stones, although it contains 98.5 per cent. of alumine.

Haüy also often deviates from this principle, and makes it subservient to another, viz. the form of the integrant particle; and when the two come in competition, preference is given to the latter.

The science has been much enriched by the researches of

these illustrious men; and their systems, although artificial, are of very great value to those who have the advantage of practical instructions and extensive cabinets; but they are by no means fitted for those who enjoy neither of these privileges.

Within the present century, the science of chemistry has made rapid advances. The powerful agency of the voltaick battery, and the practical application of the mathematical analysis, have produced wonders in chemical philosophy within the last eighteen years. The electro-chemical theory has taught us to look for substances of different electrical energies in every compound; the one acting as an acid, the other as a base. The theoryof definite proportions enables us to distinguish a compound from a mixture. Through the medium of these a new accession of light has been derived to mineralogy, and by their aid minerals will shortly be classed with the same ease, and on the same principles, as we now arrange salts.

The classification in the work before us does not exactly coincide with our notions of mineralogical arrangement; but still, we think the book answers well the purpose for which it was intended, namely, to facilitate the studies of those who have not the advantage of an instructer, and in this light, we consider it a valuable acquisition to the science. The author, long known as a highly respectable chemist and mineralogist, has here given such practical directions, as are most important to the beginner. They are delivered in a plain, easy, and familiar style, and divested of the technical and barbarous phraseology, which too often abounds in works, which are intended to be even of the more popular kind. This work includes the substance of a course of lectures, which the author delivered before the Geological Society in London. It is divided into two parts, besides the introduction, which contains directions for ascertaining the characters of minerals.

"The first object of the mineralogical student," says Mr. Aikin, "is, or ought to be, the acqusition of a facility of identifying every mineral substance, that presents itself to his notice." This constitutes the grammar of mineralogy, which has its philosophy, as well as the grammar of language. The author describes, in a clear and lucid manner, those properties which constitute the peculiar characters of minerals, and by which the different specimens are to be dis-

tinguished. These he notices under seventeen different heads, beginning with those which are "immediately obvious to the senses, and proceeding to those which require for their manifestation some apparatus or reagents which are easy of application."

He first speaks of solidity and hardness, two characters which regard the degree in which the integrant molecules of bodies cohere. "In common language hardness and refractoriness are confounded; a stone which endures many heavy blows before it gives way is considered harder than another which requires fewer blows for its fracture." The best mode of ascertaining the hardness of a mineral, is by the greater or less ease with which it yields to the point or edge of a knife of hardened steel. The comparative ease and vivacity with which a mineral gives sparks with steel is not considered as a good indication of its hardness. "In order to produce a spark, a thin minute piece of steel must be shivered from the mass, and at the same time inflamed by the violence of the concussion; hence it is obvious that among minerals of the same degree of hardness, that will afford the largest and most brilliant sparks, which breaks most easily, so as to present a number of fresh sharp edges at every blow."

After a few but important practical precautions on the use of the knife, he proceeds to consider the frangibility of bodies. This is the quality which disposes minerals to separate into fragments or pieces on the application of a blow. The phenomena presented by all those minerals which yield to the knife, are sufficient to determine the various degrees of frangibility, from absolute brittleness to malleability. The characters of frangibility and hardness, as exhibited by many minerals, are much affected by their dryness and moisture; almost every mineral in its native bed is imbued with more or less moisture.

"This moisture is often actually visible in the form of a fine dew on the recently fractured surface of a mineral, fresh from the quarry, and which is entirely exhaled in a few days; the space it occupied is filled with air, and thus a highly compressible substance is substituted for one almost incompressible; the energy of the blow is of course greatly deadened, the frangibility of the mineral is diminished, and its hardness increased."

Hence the reason why stones are used as fresh as possible in many of the arts; hence also the common observation that stones are hardened by heat, or the air.

Of structure, or the order in which the molecules of a mineral are arranged so as to form masses, the author makes three grand divisions, namely, crystalline, imperfectly crystalline, and promiscuous; and these are also subdivided.

The difference between structure and fracture, characters which have been confounded by the Wernerian schools, is also pointed out with distinctness and precision. "*Structure* is that division of the whole into smaller aggregates, which has been made by nature, according to general laws; *fracture* is the casual division of the whole into fragments." This distinction is evident. If we take, for example, a hexagonal crystal of carbonate of lime, we shall find that from three of the terminal edges of the prism, parts may be detached with ease by the aid of a cutting instrument, and that there is evidently at those places *natural joints*, through one of which the instrument has passed; but at the three other alternating edges, we find that such a section cannot be effected; that it requires some considerable force to detach any portion; that the newly exposed surface is not smooth and shining like the others, that, in short, the mineral has been forcibly broken, instead of undergoing a natural division. The first operation has reference to the structure, the second to the fracture.

With regard to their form, minerals are either crystalline, definite, or indefinite. Under the first head, a concise but clear account is given of the nature and properties of crystals. Definite forms receive particular names from their resemblance to certain bodies; thus, a mineral is said to be filiform, or capillary from its resemblance to a thread or a hair; arborescent, like a spray. All minerals, whose forms are neither crystalline nor definite, are said to be indefinite or amorphous.

The characteristick features, next considered, are those which depend on the action of light, such as transparency, lustre, and colour.

"The comparative value of characters in natural history is founded entirely on their precision, and therefore on the brevity, with which they may be expressed; but when we are told that the colours of a particular mineral are white, blue, red, green, yellow, that of the white such and such varieties occur, such and such of blue, of red, of green, and of yellow, what can candour itself infer, but that all this is egregious trifling? Where nature has shown herself so capricious with regard to one character,

she has compensated the vagueness of that, by the precision of some other."

The consideration of colour in classifying minerals, is of some importance, and it would be of still more, if an appropriate nomenclature were adapted to the several varieties of colour, which occur in minerals. But this can probably never be effected, as all persons do not see colours alike.

To the properties already mentioned are added specifick gravity, feel, odour and taste, magnetism, electricity, phosphorescence, double refraction, action of water, action of acids, and lastly, the characters exhibited on the application of the blowpipe. Respecting the form of "this little reverbuatory furnace," and the mode of using it, Mr. Aikin gives much highly useful practical information.

We have thus taken a general view of the subjects treated by the author, and the mode in which he has considered them. We think it an objection to his observations on the properties of minerals, that he has illustrated his description of characters by examples of those substances, of the nature of which the student must be supposed to be ignorant, and with which he is to become acquainted only by a knowledge of those characters; thus he gives common hornblende, apatite and fluorspar as examples of minerals *moderately hard.* Heavy spar and witherite, of *soft; toughness* is well marked in *trap,* and "the varieties of tremolite afford admirable examples of the *bladed* and *fibrous* structure;" the student knows hese substances only by name; but it is true enough this objection could not easily be obviated.

After some general remarks on the methods of Werner and Haüy, Mr. Aikin concludes that with all "their excellencies, they are by no means calculated for the use of a learner so situated as to be obliged to depend on books and on his own industry, with such specimens as he can obtain from rocks in his own vicinity." The student in mineralogy has not as yet, like the inquirers in other parts of natural history, been furnished with the means, by which he can proceed from characters the most general, to those which are specifick and particular; but this barrier to the study does not arise from the nature itself of the subject, but from incidental causes. The "manual" before us, is an attempt to supply this deficiency, and we think it well calculated for the purpose. It derives much of its excellence from the synop-

tical tables with which it is supplied. The first is a General Synopsis of minerals, by which after the manner of Cronstedt they are divided into four classes; non-metallick combustibles, of which there are two kinds, those combustible with flame, and those combustible without flame; native metals and metalliferous minerals, of which there are three orders; earthy minerals, of which there are also three orders; and saline minerals, of which there are two orders. These classes and their subdivisions are founded on the chemical properties of minerals. In addition to this general synopsis, there is also a synoptical table for each class, in which every specimen of that class is mentioned with its distinctive and diagnostick characters, with a reference to its place in the general arrangement. With the assistance of these, the student, who has learnt the characters of minerals, can easily refer his specimen to its proper place. If, for example, he has found a mineral of considerable specifick gravity, and, on subjecting it to the action of the blowpipe, finds it volatilized into vapour, which condenses on a piece of charcoal held over it, he refers it at once to the first order of the second class. But as there are many minerals belonging to this order, he looks still further, and finds this must be among those, which are totally volatilized and which leave not a metallick lustre, and he ascertains that there are seven minerals only which possess these characters. Two of the seven when heated give the odour of burning sulphur, and he discovers that the specimen under examination is one of them. Of these, the one gives a brownish red streak, the other a florid red; this latter character is possessed by his specimen, and determines it to be Cinnabar. The figure against the name refers him to its place in the general descriptive arrangement, where he finds the mineral fully described. Such tables as these are exceedingly useful, and whatever be the arrangement of minerals, which an author chooses to adopt, they will be found of inestimable value to the student. Mr. Aikin's classification is, we think, a very good one, and in a great degree natural, and with the aid of the electro-chemical theory, and definite proportions, we believe a pure scientifick system might be formed after his arrangement, or one very similar in its outlines.